Heating and Cooling

Heating, ventilating, and air-conditioning (HVAC) systems account for 39 percent of the electric energy used in commercial buildings in the United States. Consequently, almost every business has the potential to realize significant savings by improving its control of HVAC operations and improving the efficiency of the systems it uses.

1970s-Style Conservation: It Still Works

The most straightforward method for saving on your HVAC bill is simply to operate the systems less, both by turning the systems off (or back) when the building is not occupied and by choosing more efficient temperature setpoints so that the systems run less often.

A week contains 168 hours. If your business operates during only 40, or even 80, of those hours, you occupy your facility during only a fraction of the week. Consequently, savings are available by setting back your thermostat when the building is unoccupied. The term "setting back" is used to indicate both changing the temperature setting (setting back to a lower temperature in winter and setting up to a higher one in summer) and making sure that the fan switch on the thermostat is set to "auto" rather than "on." A fan left in the "on" mode runs nonstop 24 hours per day; in "auto" mode, the fan cycles on only when heating or cooling is being supplied. In some instances the fan savings can be significant even when only minimal temperature setback changes are made. If your system draws in ventilation air from outdoors, cycling the fan during unoccupied hours can also help with humidity control in humid areas.

How much can you save? That depends upon your climate, the size and shape of your building, how much you set back your thermostat, and how many hours per week your business operates. Substantial savings are also available by adjusting your temperature setpoints—lower in the winter and higher in the summer. Change your thermostat settings gradually, no more than a degree or so per week, to see how low (or high, for summer) a setting you need to maintain a comfortable facility. Make these changes without advertising the fact that you are doing so to avoid having staffers begin grumbling about changes before they can actually feel them. This method can also help identify problem areas in your system. Check out the areas where you first receive complaints about comfort to determine whether the problem is one of inadequate air supply, excessive drafts, or intense sunlight.

Hire a contractor to repair your old valves and steam traps. A steam trap costs approximately $50. If broken, it can waste hundreds of dollars each winter. One supplier estimated that an average of 20 percent of traps are broken nationwide. Broken steam traps not only waste money and energy, but they also cause extreme discomfort.

Save on your HVAC bill by turning the systems off (or back) when the building is unoccupied.

Case Study

Programmable Thermostats Bring Needed Comfort in Seattle

Centerplex, a Seattle-based ENERGY STAR® Small Business Partner, owns a 26,500-sq.ft. commercial office with 43 tenant firms and 100 occupants. Centerplex's owner, Jonathan Pool, has implemented a variety of energy-saving modifications that have reduced his electric bill by 50 percent. Among these modifications is the installation of ten programmable thermostats, which save energy by resetting the heating and cooling setpoints when sections of the facility are unoccupied. The programmable thermostats provide the added benefit of reducing tenant complaints about erratic temperatures. The programmable thermostats, along with energy-efficient lighting and window improvements, have netted a savings of $23,000 per year within an overall payback period of only 1.5 years. Mr. Pool made an interesting observation about his efficiency efforts and their ultimate effect on his bottom line. "I think there is a spillover effect. When you rent space to others the practices that you engage in attract compatible people. Conservation attracts people who support conservation. They generate less waste and are easier on both each other and the physical plant." His overhead goes down, and his profit goes up.

1980s Efficiency Improvements: Programmable Thermostats

Although night-setback and temperature-setpoint changes are simple enough to be done manually, an automatic control is much more efficient and reliable. Electronic, programmable thermostats, which allow you to program in desired setpoint and cutoff times for a 7-day week, are available for $50 to $200. Most models include manual override features, so an executive who needs to come in on a Sunday afternoon when the system is in setback mode can override the setback and work in comfort without having to reprogram the system. Be sure to locate the thermostat in a location where the temperature is representative of the entire area served by the system—not next to the air-conditioning diffuser or a coffee pot. Many businesses find it worthwhile to install a locking enclosure around their thermostats to avoid unauthorized tampering with the setpoints. If you have a heat pump, be sure you get a heat-pump-programmable thermostat with a "smart recovery" feature, which will bring your system on early enough to minimize the use of electric strip heating. Heat-pump thermostats cost about twice as much as other thermostats because they have to control multiple types of heating.

1990s and Beyond: Whole-Building Energy Optimization and Management Systems

Programmable thermostats are effective and work quite well, especially with individual-unit air conditioners and heaters. If your facility uses larger, central systems such as boilers and chillers, you may wish to use an energy management system (EMS) instead. As we approach the next millennium, the EMS market will likely expand into smaller and smaller facilities. In addition to the setpoint and night-setback features, which can be handled by a programmable thermostat, an EMS can be used to provide savings in many other ways. Depending on the type of system you have, an EMS might be used to provide some of the following money-saving automatic control functions:

- Consider installing an economizer. There may be times when you need cooling in the building but the outside temperature is low. An economizer allows your system to circulate outdoor air for free cooling during these periods. If implemented without an EMS, economizers will cost $500 to $1,000, stalled, on each rooftop unit.

- Adjust supply-air temperatures based on indoor and outdoor temperature and humidity to let the heating and cooling systems operate most efficiently.
- Adjust chilled-water and hot-water temperatures based on indoor and outdoor temperature and humidity to let the cooling and heating systems operate most efficiently.
- Implement holiday period automatic setpoint adjustments.
- Monitor space temperatures to minimize overheating or over-cooling of spaces on a zone-by-zone basis.

An EMS can be used to control other functions in your building as well, such as lighting. It can be monitored and controlled from a console in a remote location, such as your home or your maintenance manager's home. EMS suppliers typically estimate that their EMS can cut the heating and cooling bills of a business with a central chiller and heating system by 10 to 50 percent (many estimates are clustered in the 20-percent range).

Improving Your System Efficiency

The remainder of this section offers suggestions on how to improve the efficiency of various types of HVAC systems. Because advice is offered on a variety of different systems, not every suggestion will apply to your facility. One piece of advice does apply uniformly to every business, however, regardless of the type of HVAC system: **Maintain your HVAC system.**

Regular maintenance is an often-overlooked key to saving on your HVAC costs and improving the performance of your system. Although some maintenance jobs may require

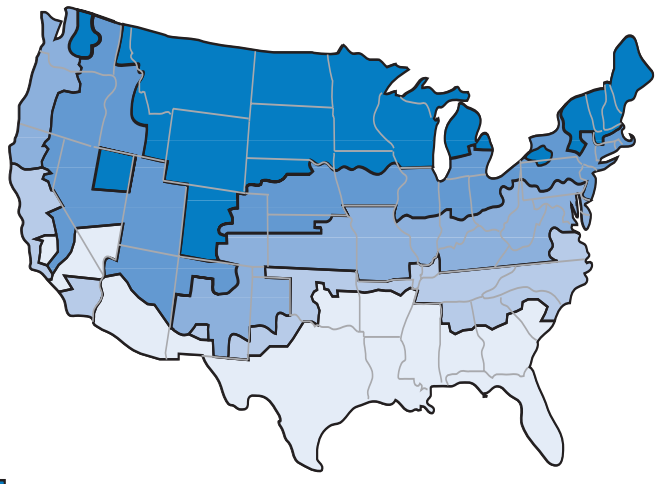
Approximate Percentage Savings From Thermostat Setback

Degree-Days*	Setback Temperature		
	60	55	50
1,000	13%	25%	38%
2,000	12%	24%	36%
3,000	11%	22%	33%
4,000	10%	20%	30%
5,000	9%	19%	28%
6,000	8%	16%	24%
7,000	7%	15%	22%
8,000	7%	13%	19%
9,000	6%	11%	16%
10,000	5%	9%	14%

*Look up your degree-days on the map below or call your utility for exact data. For a definition of "degree-day," see the glossary in section 3.

Savings based on 65 degrees Fahrenheit and assuming setback for 14 hours per weeknight and all weekend.

Source: "Reducing Energy Costs Means a Better Bottom Line." National Frozen Foods Association/U.S. Department of Energy.



Zone 1 — Greater than 7,000 heating degree-days
Zone 2 — Between 5,500 and 7,000 heating degree-days
Zone 3 — Between 4,000 and 5,500 heating degree-days
Zone 4 — Less than 4,000 heating degree-days
Zone 5 — Less than 4,000 heating degree-days and greater than 2,000 cooling degree-days

If you plan to upgrade any heating or cooling equipment, first implement your other ENERGY STAR® upgrades. Earlier upgrades (such as lighting replacements or building construction improvements) may change the size requirements for your new heating or cooling system.

calling in an outside technician, many can be accomplished inexpensively using in-house staff. Because it also extends the life of your HVAC equipment, regular maintenance provides significant cost savings for minimal investment.

Most procedures will be included in a standard preventive maintenance visit by an air-conditioning contractor. This type of system checkup will typically cost less than $100 for a single system, with additional units included at a discount. Some examples of systems checks and standard maintenance procedures that you or your contractor should do on HVAC systems include:

- *Replacing your air filters regularly.* Accumulated dirt and dust make your fans work harder. Clean filters help system performance and help reduce allergens in your office. You can do this without a whole system checkup.
- *Cleaning the heat-transfer coils in heat pumps, air conditioners, and chillers.* Make sure that leaves and plants are not obstructing outdoor coils and have any bent coils straightened. In addition to saving energy, this measure will increase the capacity of your system.
- *Inspecting ducts and piping for leakage and missing or damaged insulation and making the indicated repairs.* Insulation is especially important in unconditioned spaces.
- *Making sure that furniture or other obstructions do not block air flow around radiators, convectors, and air intakes and diffusers.*
- *Identifying any areas in your facility that are unused but are being conditioned.* Consider turning off the HVAC to these areas or closing the vents.
- *Adjusting temperature and humidity setpoints seasonally.* Unless it is absolutely required for humidity control, consider turning off "reheat" from late spring to fall.
- *Having your fuel-fired boiler or furnace checked out at least annually, before the heating season starts.* Have the technician check the combustion efficiency and report the results along with any suggestions for improving boiler efficiency.

In addition to the maintenance changes suggested here, making operational changes and/or upgrading some aspects of your HVAC system may result in significant savings. These upgrades are more complex in scope and should be undertaken only after consultation with an engineering professional.

This is Stage Five

Do you remember the five-stage approach from pages 31 and 32? If you plan to upgrade any heating or cooling equipment, be sure to do this *after* your other ENERGY STAR upgrades have been implemented because your earlier upgrades (such as lighting replacements or building construction improvements) may result in a change in size requirements for your new heating or cooling system. If you have a large or architecturally unique site, insist that the contractor complete a sizing worksheet or run a computerized sizing analysis for your facility in its current state of repair. If you think the results inflate your needs, seek another quote.

Never buy oversized heating or cooling equipment on the theory that more capacity is better. This simply is not true. Grossly oversized cooling equipment will cycle too often and will be unable to sufficiently dehumidify your space, which creates a serious comfort issue. Such equipment will also cost more to run all year long. Heating equipment will be equally inefficient

if oversized. This advice is difficult, perhaps the most difficult in this whole guide, to follow. Nobody wants to spend $5,000 on a new air conditioner and find themselves sweating when cooling is sought. But both comfort and costs are at stake. Get the right size, not the right size plus one, and you'll be happy.

If your system was properly sized before making any ENERGY STAR improvements, your contractor may find that your system is now oversized and savings can potentially be realized by downsizing portions of it. If your system was undersized before you began your ENERGY STAR upgrades, you may find that your improvements have, in effect, balanced your loads and capacity by reducing your building loads and increasing your equipment capacity.

Hot New Technologies: Variable-Speed Drives, Heat Recovery, and Radiant Heating

Variable-Speed Drives (VSDs). If you have a larger system in your building, you may be able to take advantage of the savings available through installing VSDs on air blowers or even pumps. VSDs allow sophisticated control of how much air or water is provided by heating and cooling equipment, which has a significant effect on how much energy is consumed.

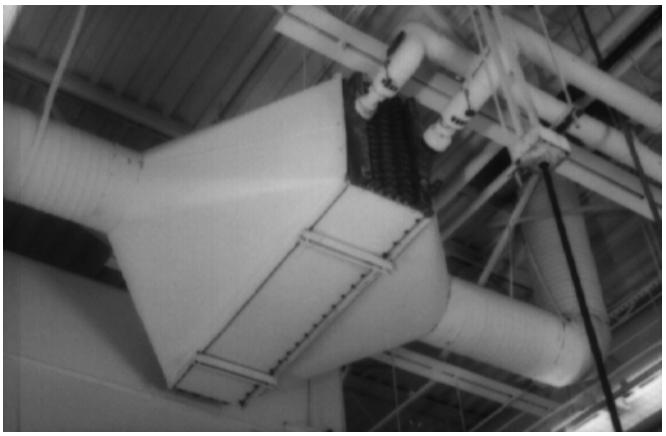
Heat Recovery. Your business may require high levels of fresh air (for example, a laboratory with fume hoods). Installing heat recovery equipment will allow you to recapture some of the energy you have invested in heating or cooling that air and transfer it to the fresh air stream.

Radiant Heating. For areas where high ceilings, high infiltration, or low insulation levels make heating the air costly, natural gas-fired radiant heating (which heats occupants directly) is the answer. For warehouses, shop areas, and loading dock areas, installing radiant heaters can lead to big savings on your heating bills.

To find out more about these and other technologies, call the toll-free ENERGY STAR hotline at 1-888-STAR YES and ask for materials suited to your business. And remember, we're here to provide you with unbiased technical information for all your energy-efficiency upgrades.

Tips for Selecting Heating and Cooling Systems

- Proper sizing is critical to efficient performance.
- Check if utility rebates are available.
- When buying smaller heating or cooling equipment, look for the ENERGY STAR logo—your guarantee of savings.
- Call the ENERGY STAR hotline (1-888-STAR YES) to request all the materials you need to make you an "energy smart shopper."



This heat recovery unit transfers energy from the exhaust air to the incoming air, lowering heating and cooling costs. Heat recovery is cost effective in facilities such as laboratories, restaurant kitchens, or automotive shops that have large, central exhaust systems.

Case Study

HVAC Equipment Pays Back in North Carolina

The cost of replacing HVAC equipment can be a burden for a small business, but a smart shopper can use the replacement as an opportunity to reduce operating costs by purchasing energy-efficient equipment.

Sud Associates, an engineering firm in Durham, NC, needed to replace HVAC equipment in its 2,200-sq.ft. office building. The 23-year-old system was a gas furnace with a continuously burning pilot light and an open flue. Cooling was provided by a condensing unit with a poor seasonal energy efficiency ratio (SEER) of 7.

The new heating system included a gas furnace with electronic ignition and a forced draft fan. Cooling equipment with a SEER of 12 was installed. This new system outperforms the old one, cutting both electric and gas usage while increasing comfort. The electronic ignition eliminates the continual gas use by the old pilot light, and the forced draft fan contains any heat lost through an open flue. The new gas furnace has cut gas usage by more than 20 percent in its first heating season. Elimination of the pilot light's energy use will add to the total savings. As the system is in its first year of installation at the time of this writing, actual cooling savings results are not available. However, electric savings due to the increased energy efficiency of the cooling equipment is predicted to be approximately 40 percent.

Time for Another Repair?

Due to the high cost of large HVAC equipment, the energy savings alone may not justify replacement of equipment that is in good working order. If your equipment requires frequent repairs or is nearing the end of its life expectancy, however, it may be wise to consider replacing it from a preventive maintenance standpoint and an energy savings standpoint, as a scheduled replacement can generally be negotiated at a lower cost and with less inconvenience than the emergency replacement of a failed unit. Call your utility to find out if it offers rebates on high-efficiency equipment.

Technical Talk: Special Types of Heating and Cooling Systems

Systems That Simultaneously Heat and Cool. In reheat systems, air that is colder than required is supplied to a specific area and then reheated before it enters the room. In dual-duct or multizone systems, heated air is mixed with cooled air. Although these systems provide good temperature and humidity control, this simultaneous heating and cooling is inherently wasteful and should be minimized. If this is being done for humidity control, consider alternatives such as desiccants and heat pipes.

Single-Zone Chilled-Water Systems. Consider reducing the air volume and, during relatively dry seasons, raising the cooling supply temperature. Also consider conversion to a variable-air-volume (VAV) system.

Water-Side Systems. Consider downsizing oversized pumps and motors, installing variable-speed drives on pump motors, and converting single-loop configurations to a configuration with primary and secondary loops.

Water-Cooled Centrifugal Chillers. If your chiller predates 1990, it may be using R-11 or R-12 refrigerants. Manufacture of these has been banned due to the Clean Air Act of 1991, reducing their availability and making their prices skyrocket, so any upgrade should consider converting the chillers to utilize newer refrigerants. Consider replacing your chiller if it is more than 20 years old.

Boilers. Consider replacing an oversized, inefficient boiler with a smaller, more efficient boiler. Also consider upgrading an existing boiler with energy savings options such as a newer, more efficient burner (which will also reduce emissions), baffle inserts (to increase the efficiency of fire-tube boilers), combustion controls (to optimize efficiency each hour), warm-weather controls for hot-water boilers (to reduce the water temperature during milder weather), economizers (to preheat feedwater), and condensate return systems (for open-loop steam boiler systems). If you have multiple boilers, keep in mind that it is more cost effective to run one of them at full load than both at part load.

Large Central Systems. If you have a large central system and you find that one area of your facility operates for substantially more hours than the others, it may be cost effective to install a smaller, dedicated system in that area.

Other Ideas for Energy Optimization

Ideas on energy optimizations and related profit enhancements are far more numerous than the ones presented in this guide. The possibilities are endless. In this section we will point out a few more specific ideas, but don't let us constrain you. Anywhere energy is used can be an opportunity for improvement.

Motors

The rules of thumb here are simple. First, buy high-efficiency motors whenever you replace old motors. Second, if you use a standard efficiency motor (less than 100 horsepower) 24 hours every day, replace it with its high-efficiency equivalent right away and your profits will increase in less than five years. Beyond that, your decision is mainly a factor of the motor-cost premium, hours of use, and your electricity cost, shown in the table in dollars per kilowatt-hour ($/kWh).

Cooking Equipment

Don't preheat your cooking equipment. Don't preheat your electric or gas equipment for more than a few minutes. Although chefs are not likely to appreciate your telling them how to run their kitchens, it's worth a try.

Use the microwave or gas stove in place of electric resistance cooking when possible. Both cost less.

Buy the efficient version. Many fryers, broilers, soup kettles, and other equipment have optional controls and features that minimize their energy use. Often they are worth the additional cost, but we cannot offer a guarantee.

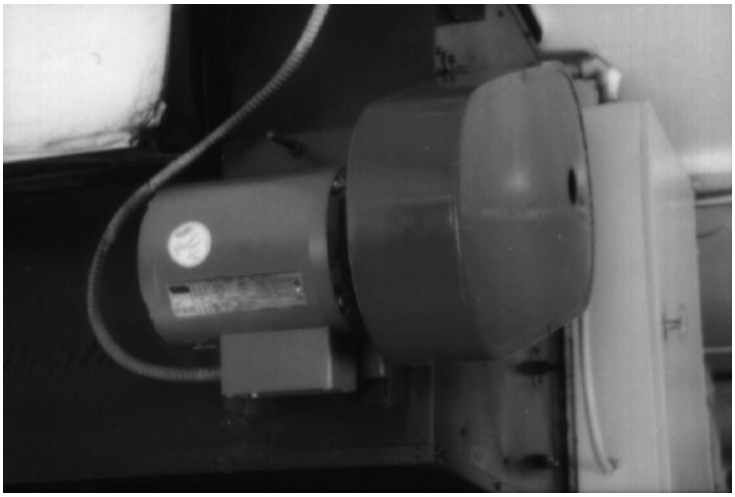
Improve kitchen ventilation. Turn off your makeup air unit whenever you are not cooking and especially at night. These units, together with the exhaust hoods, demand tremendous amounts of energy. You need to provide a safe and comfortable environment without odors and smoke, but turn both systems off when they are not needed.

Should You Buy a High-Efficiency Motor?

Example: 25 Horsepower Motor
$208 Cost Premium for High-Efficiency Motor
$1,028 Total Cost for High-Efficiency Motor

Motor Use Hours/Year	Annual Cost Savings at Electric Rate Shown			
	$0.05	$0.08	$0.10	$0.12
1,000	$28	$44	$56	$67
2,000	$56	$89	$111	$133
4,000	$111	$178	$222	$267
6,000	$167	$267	$333	$400
8,760	$243	$389	$486	$584

Always buy standard efficiency.
Buy high-efficiency motor upon burnout.
Buy high-efficiency motor immediately.



This blower operates 24 hours a day, supplying fresh air to this all-night business. The nameplate on the front of the motor indicates 78-percent efficiency. Replacing it with a new 87-percent efficiency motor could save $82 a year (at $0.08/kWh), paying back the investment in 3 to 4 years.

Fuel Conversions

Electric resistance heating is typically the most expensive option when compared with natural gas, propane, and other fuels. If you already have gas onsite but still use electric-resistance heat for water heating, clothes drying, cooking, or other processes, ask your plumbing or general contractor to tell you what it will cost to convert your equipment. It could be a very good investment for equipment you use often or were going to replace anyway.

The Bottom Line

Invest in energy optimization. It makes good business sense for so many reasons. You'll typically get a 30-percent return—or better—on your investment, and ENERGY STAR Small Business will help you find sources that can provide financing if initial funding is a problem.

ENERGY STAR Small Business Partners profit because of cost savings and because sales and productivity can increase. EPA provides Partners with good press, Web links, posters, and a variety of tools that can help you promote your responsible management of natural resources. This marketing can turn into increased sales. New, efficient technologies can also help with sales directly by making your products look better and by making employees more comfortable and productive. All of these ideas ultimately help your bottom line.

Don't worry. You don't have to become an energy expert or spend a lot of time working on new projects to get all these benefits. Because you're a Partner, we'll help you find reliable auditors and contractors so you can turn your attention back to your business. When you do need technical support to be a smarter shopper, we're here with the information you want. Call us at **1-888-STARYES** or visit our Web site at **www.epa.gov/smallbiz**.

What's left to decide? Call an expert and get started!

3

Supporting Material

Supporting Material

Glossary

AHU: See Air Handling Unit.

Air Diffuser: A device used to distribute heated or cooled air to a space.

Air Handling Unit (AHU): A unit that usually contains filters, fans, and other components to heat, cool, humidify, or dehumidify interior air.

ASHRAE: American Society of Heating, Refrigerating, and Air-Conditioning Engineers.

Ballast: A device in fluorescent and high-intensity discharge (HID) lighting units that modifies incoming voltage and controls current.

Blending Valve: A valve that mixes hot and cold water to provide water at a lower temperature.

Boiler: A vessel designed to transfer heat produced by combustion or electric resistance to water. Boilers may provide hot water or steam, depending on design and settings.

British Thermal Unit (BTU): A unit of heat energy equal to the amount of heat required to raise the temperature of one pound of water by one degree Fahrenheit at sea level. This is roughly equivalent to the heat given off from burning a wooden match.

Building Envelope: The exterior surface of a building's construction—the walls, windows, doors, roof, and floor. Also called the building shell.

CFL: See Compact Fluorescent Lamp.

CFM: Cubic Feet per Minute, a measure of air flow.

Chiller: A device that generates a cold liquid that is circulated through an air-handling unit's cooling coil to cool the air supplied to the building.

Color-Rendering Index (CRI): A scale indicating the effect that a given light source has on the apparent color of objects viewed under it. It is expressed on a scale of 0 to 100, where 100 represents the color appearance of the object in daylight or under incandescent lights. Values of CRI above 80 indicate good color rendition.

Compact Fluorescent Lamp (CFL): Small fluorescent lamps frequently used as more efficient alternatives to incandescent lighting. They typically have 10 times the rated life and 3 to 4 times the efficacy of incandescent lamps.

Condensate Return System: A system of piping that returns the heated water condensing within steam piping to the boiler and thus saves energy.

Glossary

Condenser: Heat exchanger in a refrigeration system that rejects heat from the system.

Convector: A heating unit that circulates heated air by means of natural convection. Normally consists of a heating element within an enclosure, with an air inlet below and an air outlet opening above.

Cooling Tower: A device that dissipates the heat from water-cooled systems by spraying the water through streams of rapidly moving air.

CRI: See Color-Rendering Index.

Dampers: Single or multiple blades that are opened or closed in order to control the amount of air entering or leaving an air-conditioning system. Control can be either manual or automatic.

Deep-Cell Parabolic: A type of fluorescent fixture recommended for areas with computers. These fixtures direct light down, minimizing glare and reflections in computer monitors. See also louvers.

Degree-Day: A rough measure used to estimate the amount of heating required in a given area. A degree-day is defined as the difference between the mean daily temperature and 65 degrees Fahrenheit (F). This is based upon the assumption that no heating is required when the temperature is above 65° F, and that proportionately more heating is required the further the average temperature is from 65° F. Cooling degree-days may also be calculated to estimate cooling requirements.

Demand: The average rate of electrical usage used over a specified period of time (typically a 15-minute, 30-minute, or 1-hour period). Measured in kilowatts (kWs).

Demand Charges: Fees charged by a utility company for electric demand. These charges are often highest during weekdays in summer.

Desiccant: A substance that is capable of extracting and retaining water from humid air.

Dual Duct: A type of heating, ventilating, and air-conditioning (HVAC) distribution system that involves simultaneous heating and cooling. Two supply ducts (a "hot deck" and a "cold deck") serve each space, and the hot and cold air from them are mixed in the appropriate proportions before being supplied to the space.

Economizer: A mode of HVAC operation using outdoor air for cooling when outdoor temperature and humidity levels are suitable.

Efficacy: A measure of how efficiently a light source can produce light, expressed in lumens (of light output) per watt (of power input). For example, a 100-watt light source producing 9,000 lumens of light output has an efficacy of 90 lumens per watt.

Glossary

Efficiency: A measure of how much of a desired output is produced per unit of input; typically calculated as the amount of useful energy supplied divided by the energy consumed.

Electric Resistance Heat: Heat produced by a flow of electricity through high-resistance wire, tape, or film.

Electronic Ballast: A ballast for fluorescent lights that uses semiconductor components to increase the incoming electrical frequency from 60 hertz (Hz) to much higher levels (20,000 to 40,000 Hz), allowing lamps to operate with virtually no flicker and consume 12 to 25 percent less power than with standard ballasts.

Electronic Dimming Ballast: An electronic ballast that allows variable levels of light output.

EMS: See Energy Management System.

Energy Management System (EMS): A control system capable of monitoring environmental and system loads and adjusting HVAC operations accordingly in order to conserve energy while maintaining comfort. It may also be used for other control and monitoring, such as lighting and security.

Engine-Driven Chiller: A type of chiller that uses an engine fueled by natural gas, fuel oil, or diesel fuel instead of an electric motor.

Envelope (Building): The exterior surface of a building's construction—the walls, windows, doors, roof, and floor. Also called the building shell.

Feedwater: The water that is fed into a boiler to be heated.

Filter: A device that removes fine particles from the air stream in an air-handling system.

Footcandle (fc): A unit of measurement of the lighting levels on a surface, equal to one lumen per square foot.

Geothermal Heat Pump: See Ground Source Heat Pump.

GPM: Gallons Per Minute, a measure of flow rate for water or other liquids.

Gravity Dampers: Devices that close off a duct automatically by force of gravity when not kept open by fan-forced air flow.

Ground Source Heat Pump: Also called "Earth Coupled" and "Geothermal," these heat pumps use underground coils to transfer heat from the ground to the inside of a building. Compared with conventional heat pumps, ground source heat pumps can have 40-percent higher efficiency but cost more to install. See also Water Source Heat Pump.

Halogen: A type of incandescent lamp with higher efficiency than standard incandescent lamps. Halogen produces a bright white light ideal for retail applications.

Glossary

Head: Pressure that a pump or fan has to work against for liquids to flow.

Heat Pipe: A passive heat exchanger that uses a refrigerant as the heat transfer medium.

Heat Pump: An electric device with both heating and cooling capabilities. It extracts heat from one medium at a lower temperature (the heat source) and transfers it to another medium at a higher temperature (the heat sink), thereby cooling the first and warming the second.

Heat-Transfer Coils: A component of heat pumps, air conditioners, and chillers that is used to transfer heat. They must be kept clean and clear of obstructions to operate efficiently.

HID: See High-Intensity Discharge.

High-Intensity Discharge (HID): A generic term used to describe mercury vapor, metal halide, and high-pressure sodium lamps and fixtures. Low-pressure sodium lamps, although not technically HID, are sometimes informally included in the use of this term.

High-Pressure Sodium (HPS): An efficient type of lighting often used for warehouse and exterior lighting. HPS fixtures emit a slightly yellow-orange light.

HPS: See High-Pressure Sodium.

Humidifier: A device that adds moisture to air.

HVAC: Heating, Ventilating, and Air Conditioning.

Hydronic: A ventilation system that uses heated or cooled water circulated by pumps throughout the building.

Illuminance: A measure of the amount of light incident on a surface or plane, expressed in lumens per square foot (footcandles) or lumens per square meter (lux). Commonly referred to as "light level."

Internal Rate of Return (IRR): IRR is the interest rate that is equivalent to the present value of expected future cash flows after considering the initial cost of the project.

IRR: See Internal Rate of Return.

Kilowatt (kW): Unit of power (demand) equal to 1,000 watts.

Kilowatt-hour (kWh): A unit of electric energy equal to the energy consumed by a 1-kilowatt load operated for one hour.

LED: See Light-Emitting Diode.

Lens: A translucent or transparent piece of glass or plastic that shields the light source and redirects and scatters light passing through it.

Light-Emitting Diode (LED): An illumination technology used for exit signs that requires very little power and has a rated life greater than 80 years.

Glossary

Louver: Grid type of optical assembly used to control light distribution from a fixture. Can range from small-cell plastic louvers to the large-cell anodized aluminum louvers used in parabolic fluorescent fixtures. See also Deep-Cell Parabolic.

Low-Emissivity (low-E) Windows: A new window technology that lowers the amount of energy loss through windows by inhibiting the transmission of radiant heat while allowing plenty of light to pass through.

Low-Voltage Halogen: An incandescent lamp that produces bright white light at a higher efficiency than standard incandescent lamps. The high "sparkle" from low-voltage halogen lamps makes them well suited for retail spot lighting.

Lumen: A unit of measurement of light flow or luminous flux (the quantity of light emitted from a light source).

Luminaire: A complete lighting unit, consisting of one or more lamps, a housing, the optical components to distribute light, and electrical components (ballasts, starters, etc.) necessary to operate the lamps.

Megawatt: One million watts.

Metal Halide (MH): A type of lighting that combines high efficiency and an appealing bright white light. MH fixtures can be used for interior and exterior lighting. They are becoming the fixture of choice for retail areas with high ceilings.

MH: See Metal Halide.

Mixing Box: A component of an air-handling system in which air streams from two different sources are combined to form a uniform air stream.

Modified Bin Method: A method for calculating the required heating or cooling for a building based on determining how much energy the system would use if outdoor temperatures were within a certain temperature interval (or "bin") and then multiplying that energy use by the amount of time that the temperature interval typically occurs at the site. Bin weather data for a variety of sites are tabulated by both the U.S. Air Force and ASHRAE. The energy use for all of the applicable temperature bins is summed to determine the total estimated energy use by the system.

Multizone: A type of HVAC distribution system that involves simultaneous heating and cooling. Hot and cold air are supplied at the multizone unit and mixed in appropriate proportions to provide the supply-air temperatures needed in each zone.

Occupancy Sensor: A device that detects the presence (or absence) of occupants in an area and causes equipment to be adjusted accordingly.

Payback, Simple: A traditional measure of the economic viability of a project, generally defined as the length of time it takes for savings from an investment to equal the cost. Although frequently used because of its ease of calculation,

Glossary

payback frequently does not give an accurate representation of the total lifecycle value of an investment.

Photocell: A light-sensing device used to control light fixtures and dimmers in response to detected levels.

Prismatic Plastic Lens: The cover installed on many standard fluorescent fixtures. These lenses are often bright light sources that create uncomfortable reflections in computer monitors.

Programmable Thermostat: A control device for HVAC systems that allows the user to program in various temperature and fan settings for various times.

Radiant Heaters: A technology that heats building occupants by radiating heat from an electric or combustion source. Because radiant heaters use radiation instead of convection to transfer heat, they are very efficient in areas where high ceilings or high infiltration make heating the air costly.

Refrigerant: A substance used to provide cooling, either as the working substance of a refrigerator or by the direct absorption of heat.

Reheat: A type of HVAC air distribution system in which air maintains comfort in a building by cooling the air to a low temperature (typically 55 degrees F) at the air handler and then reheats it near its point of use. This system provides good temperature and humidity control but wastes considerable energy.

Retrofit: Upgrading a fixture, room, or building by installing new parts of equipment.

R-Value: A measure of thermal resistance or the ability of a material or group of materials to retard heat flow.

Setback: Setting a thermostat to a lower temperature when the building is unoccupied to reduce heating energy consumption. This may also refer to setting the thermostat to higher temperatures ("setup") during unoccupied periods in the cooling season and operating the fan in "auto" mode (rather than constant operation) during unoccupied periods.

Shading Coefficient: The amount of the sun's heat transmitted through a given window compared with that of a standard 1/8-inch-thick single pane of glass under the same conditions.

Static Pressure: The condition that exists when an equal amount of air is being supplied to and removed from a space.

Steam Trap: A valve that allows condensed water to flow out of a steam supply line without allowing any of the steam to escape.

Supply-Air Diffuser: A device used to evenly distribute supply air to a space.

Tandem Wiring: A wiring option in which a ballast is shared by two or more fixtures. This option reduces labor, material, and energy costs.

Glossary

Thermostat: A device typically contained in heating, cooling, and refrigeration systems which automatically responds to temperature changes and activates switches controlling the equipment.

Ton: A unit of measure of refrigeration or air-conditioning capacity; by definition equal to 12,000 BTU/hour. This is a holdover from when refrigeration was primarily used to make ice (for people to use in home iceboxes). A "three ton" refrigeration unit could make three tons of ice from 32 degrees F water in a day.

T-12 Lamp: Industry standard nomenclature for a fluorescent lamp which is twelve 1/8 of an inch (1 1/2 inch) in diameter. Other standard lamp sizes include T-8 (1 inch), T-10 (1 1/4 inch), and T-5 (5/8 inch).

Variable Air Volume (VAV): A type of air-handling system that maintains comfort in a building by supplying varying quantities of air throughout the building based upon the needs of individual spaces.

Variable-Speed Drive (VSD): A device that is used to adjust the speed of an AC motor to match load requirements. Since motors require less power to operate at slower speeds, this provides energy savings.

VAV: See Variable Air Volume.

VSD: See Variable-Speed Drive.

Waste Heat Recovery: Recovering heat that is discharged as a byproduct of one process to provide heat required by a second process. For example, recovering heat going up the flue of a boiler to be used to preheat boiler feedwater.

Water-Side Systems: HVAC systems in which water is used to provide heating or cooling, including pumps, chillers, boilers, and other equipment.

Water Source Heat Pump: Heat pumps that use wells or heat exchangers to transfer heat from water to the inside of a building. Although most of these units use ground water, a small number of installations use surface water, such as ponds or streams. Compared with conventional heat pumps, water source heat pumps can have 50-percent higher efficiency, but cost more to install. See also Ground Source Heat Pump.

Watt (W): A unit of electric power. It defines the rate at which electric energy is consumed.

Xeriscaping: (From the Greek *xer*, which means dry.) A technique of utilizing native, hardy, low-maintenance plants for landscaping. Xeriscaping reduces water, pesticide, and fertilizer requirements.

Zone: A distinct area to which heating or air conditioning is supplied.

FREE Publications and Programs

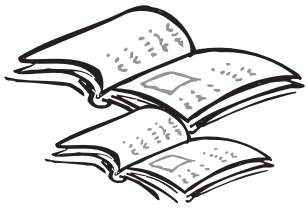
Request any of the following free materials by calling 1-888-STAR YES. And remember, ENERGY STAR® Small Business Partners may request information related to any program, not just the Small Business program. EPA updates the material in this fast-changing marketplace regularly. Call for the latest information.

Information on the EPA ENERGY STAR Family of Programs

- ENERGY STAR Small Business: for businesses of 100,000 square feet or less
- ENERGY STAR Buildings: for businesses greater than 100,000 square feet
- ENERGY STAR Buildings Allies: for companies involved in the energy efficiency business
- ENERGY STAR Office Equipment: for companies that sell computers, copiers, and other office equipment
- ENERGY STAR Residential: for home builders
- ENERGY STAR Transformers: for electric utility companies
- ENERGY STAR Heating and Cooling: for residential heating and cooling system manufacturers

The following types of information are available for all of the above programs

- Information packs: general program information
- Technologies: reports on high-efficiency equipment (available for the Buildings, Heating and Cooling, and Office Equipment programs)
- Case studies
- Analytical software tools
- Communications and promotional materials



Average Energy Use and Costs Throughout the United States

Calculate Your Total Energy Intensity

1. Collect one year of bills for each energy type and multiply by these conversion factors:

   Annual kWh of electricity x 3.4 _____

   Annual therms or ccf of natural gas x 100 _____

   Annual gallons of #2 fuel oil (diesel fuel) x 140 _____

   Annual gallons of #6 fuel oil x 150 _____

   Annual Mlb. of purchased steam x 1040 _____

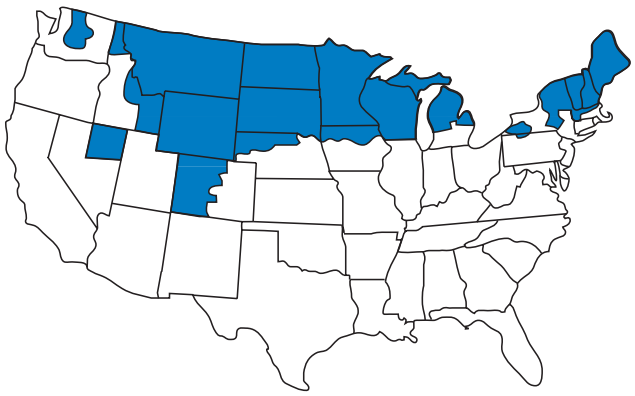
   Annual gallons of propane x 91 *or*
   Annual pounds of propane x 22 _____

   Total (A) _____ kBtu/year

2. Write down the size of your facility, in square feet (B) _____ square feet

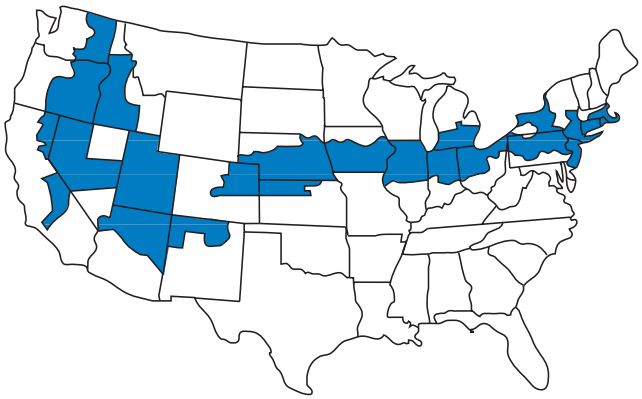
3. Calculate your total energy intensity by dividing (A) by (B), and write this number on line (C). (C) _____ kBtu/sq.ft./year

4. Find the climate map with your location shaded. Then find the average energy use and costs for similar buildings on the adjacent table and compare them with your energy use from line (C). How do you rate?



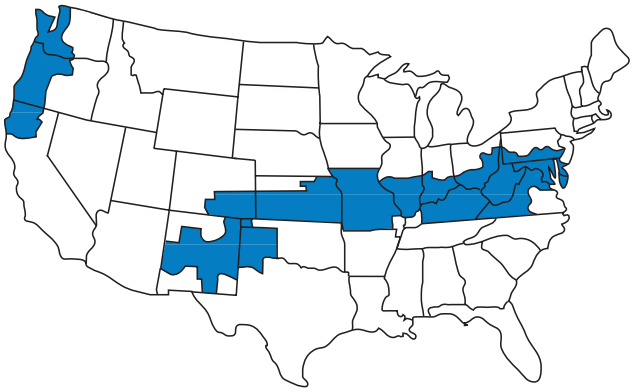
U.S. Climate Zone 1

Building Type	Annual Energy Use (kBtu/sq.ft.)	Annual Energy Cost ($/sq.ft.)
Education	77	$0.93
Food service	155	$2.32
Health care (inpatient)	270	$2.65
Health care (outpatient)	118	$1.33
Lodging	133	$1.42
Office	93	$1.46
Public assembly	66	$0.95
Religious worship	53	$0.48
Restaurant	250	$3.99
Retail	77	$0.99
Warehouse (non-refrig.)	59	$1.09
Warehouse (refrigerated)	65	$1.45



U.S. Climate Zone 2

Building Type	Annual Energy Use (kBtu/sq.ft.)	Annual Energy Cost ($/sq.ft.)
Education	88	$1.08
Food service	169	$2.19
Health care (inpatient)	269	$2.63
Health care (outpatient)	84	$1.25
Lodging	92	$1.54
Office	95	$1.49
Public assembly	77	$1.26
Religious worship	61	$0.68
Restaurant	250	$3.99
Retail	87	$1.21
Warehouse (non-refrig.)	64	$0.80
Warehouse (refrigerated)	65	$1.45



U.S. Climate Zone 3		
Building Type	**Annual Energy Use (kBtu/sq.ft.)**	**Annual Energy Cost ($/sq.ft.)**
Education	69	$0.99
Food service	213	$2.73
Health care (inpatient)	204	$2.35
Health care (outpatient)	80	$1.30
Lodging	96	$1.86
Office	80	$1.59
Public assembly	66	$1.19
Religious worship	35	$0.45
Restaurant	226	$4.16
Retail	64	$1.25
Warehouse (non-refrig.)	51	$0.93
Warehouse (refrigerated)	65	$1.47

U.S. Climate Zone 4		
Building Type	**Annual Energy Use (kBtu/sq.ft.)**	**Annual Energy Cost ($/sq.ft.)**
Education	66	$1.17
Food service	232	$2.49
Health care (inpatient)	227	$2.89
Health care (outpatient)	74	$1.36
Lodging	115	$1.65
Office	72	$1.54
Public assembly	72	$1.32
Religious worship	38	$0.59
Restaurant	134	$3.03
Retail	68	$1.36
Warehouse (non-refrig.)	36	$0.83
Warehouse (refrigerated)	96	$2.02

U.S. Climate Zone 5		
Building Type	**Annual Energy Use (kBtu/sq.ft.)**	**Annual Energy Cost ($/sq.ft.)**
Education	56	$1.11
Food service	195	$2.89
Health care (inpatient)	202	$2.76
Health care (outpatient)	100	$1.67
Lodging	102	$1.62
Office	68	$1.55
Public assembly	54	$1.17
Religious worship	34	$0.59
Restaurant	161	$3.20
Retail	56	$1.26
Warehouse (non-refrig.)	33	$0.77
Warehouse (refrigerated)	55	$1.17

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Energy-Efficiency Quicklist

This guide recommends a lot of different energy upgrades. Where should you start? First walk through your business with this Quicklist in hand and use it to identify money-saving opportunities. Then post the Quicklist on your wall and check off items as you perform upgrades to keep track of your progress.

Lighting

- [ ] Replace incandescent light bulbs with compact fluorescent lamps
- [ ] Convert exterior lighting to high-pressure sodium or metal halide lighting
- [ ] Upgrade fluorescent fixtures with T-8 fluorescent lamps and electronic ballasts
- [ ] Remove or disconnect unnecessary lights
- [ ] Convert exit signs to LED
- [ ] Lower light levels where appropriate, such as around computer monitors
- [ ] Install occupancy sensors in areas such as bathrooms that are frequently unoccupied
- [ ] Install timers or photocells on outside lights

Water Use and Water Heating

- [ ] Install a water heater insulating blanket and wrap the first three to six feet of hot water supply pipe with pipe insulation
- [ ] Install faucet aerators and efficient showerheads
- [ ] Select native or other low-water plants for landscaping
- [ ] Find and fix leaks

Refrigeration

- [ ] Repair doors and seals so they close tightly
- [ ] Make sure fans and equipment are not obstructed
- [ ] Combine refrigerated goods and disconnect unneeded refrigerators

Building

- [ ] Install weather stripping, caulking, or seals on openings that create drafts
- [ ] Add or repair insulation to create a continuous blanket around building

Heating and Cooling Systems

- [ ] Clean and replace filters regularly
- [ ] Set back your heating, ventilating, and air-conditioning (HVAC) systems when the building is unoccupied. This includes setting the fans to “auto” rather than “on.”
- [ ] Repair leaks in system components such as pipes, steam traps, and couplings
- [ ] Make sure radiators, convectors, air intakes, and air diffusers are not obstructed so that air can flow freely
- [ ] Reduce your water heater settings to the minimum required temperature

ENERGY STAR® Small Business Building Shopping List

Buying or leasing a building with these preferred technologies can lower your operating costs and may give you a competitive advantage. Use this list when walking through a prospective building to see if the building will help or hurt your profit. Call 1-888-STAR YES if you have any questions.

Lighting

		Yes	No
General	T-8 Fluorescent Lamps	___	___
	Compact Fluorescent Lamps	___	___
	Occupancy Sensors	___	___
	LED Exit Signs	___	___
	Low-Glare Daylight	___	___
Warehouse	High-Pressure Sodium (HPS) or Metal Halide (MH) Lighting	___	___
Retail	Halogen	___	___
Office	Light Level Below 75 Foot-candles	___	___
	Deep-Cell Parabolic Fixtures	___	___
Exterior	HPS or MH	___	___
	Photocells or Timers	___	___

Hot Water

	Yes	No
Insulated Pipes	___	___
Water Heater Insulating Blanket	___	___
Faucet Aerators	___	___
Efficient Showerheads	___	___
Solar Hot Water	___	___

Building

	Yes	No
Low-E Windows	___	___
Awnings To Block Summer Sun	___	___
Window Film	___	___
Roof Insulation	___	inches
Wall Insulation	___	inches
Tight-Closing Doors/ Windows	___	___
Reflective Roof	___	___
Operable Windows	___	___

Heating and Cooling Distribution

	Yes	No
Energy Management System	___	___
Programmable Thermostats	___	___
Variable-Speed Drives	___	___
Energy-Efficient Motors	___	___

Heating

	Yes	No
High-Efficiency Gas Furnace	___	___
Pulse Combustion Boiler	___	___
High-Efficiency Heat Pump	___	___
Insulated Pipes/Ducts	___	___
Ducts All Inside Building Envelope	___	___
Electronic Ignition (No Pilot Light)	___	___

Cooling

	Yes	No
Newer High-Efficiency Cooling Units	___	___
Economizers/"Free Cooling"	___	___
Coils Clean and Free of Moisture	___	___

Other

	Yes	No
Locker Room	___	___
Access to Bike Path	___	___
Subway or Bus Nearby	___	___
Xeriscaping	___	___
Lease That Rewards Efficiency	___	___

Notes

We Took Action!

☐ **Please send my completion certificate.**

Name _____

Business Name _____

Address _____

City _____ **State** _____ **ZIP** _____

Phone _____

Here's What We Did:

Stage One: Lighting

	Yes
Compact Fluorescent Lamps	____
T-8 Fluorescent	____
High-Pressure Sodium or Metal Halide Lighting	____
Occupancy Sensors	____
Other Controls	____
LED Exit Signs	____

Stage Two: Building Tune-Up

Set Up Scheduled Maintenance	____
Heating/Cooling System Tune-Up	____
Heating/Cooling	____
New Controls or Emergency Management Systems	____
Hot Water Tank and Pipe Insulation	____
Reduce Hot Water Use	____

Stage Three: Load Reduction

	Yes
Building Insulation	____
Leakage Reduction	____
New Windows	____
Window Film/Solar Screens	____

Stage Four: Heating and Cooling Distribution System

High-Efficiency Fan and Pump Motors	____
Variable-Speed Drives	____

Stage Five: Heating and Cooling Plant

New, High-Efficiency Air Conditioning	____
New, High-Efficiency Heating	____
System Upgrades	____

Other _____

My Bills

I rent/own (circle one) my space.
Have all planned upgrades been completed?
Yes or No (circle one) If yes, when? _____
Square footage upgraded _____

Annual Savings

Total $ (all bills)_____, actual or estimated (circle one)
Electric Savings _____, kWh or dollars (circle one)
Gas Savings _____, therms or dollars (circle one)
Oil Savings _____, gallons or dollars (circle one)

☐ **Please send me the public recognition information pack.**
☐ **I'd like to be considered for a case study about my upgrade.**

Comments

_____
_____
_____
_____
_____
_____
_____

Place
Stamp
Here

Program Manager
ENERGY STAR Small Business Program
U.S. EPA 6202J
401 M Street SW
Washington, DC 20460

(fold here)